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INVESTIGATION OF THE STUDENT TEACHERS' SKILLS OF TRANSITION BETWEEN MULTIPLE REPRESENTATIONS ABOUT PRESSURE

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ABSTRACT

The aim of this study was to investigate performance of student teachers regarding skills translating verbal representation to graphical, table and physical representations. The study group was constructed with the participants of 45 student teachers. Data of the study was collected with open-ended questions. The results of the study indicated that although almost all of the student teachers defined the concept of pressure as scientifically, most of them did not showed a good performance for the transitions. It was recommended that some sample applications to improve student teachers' skills of transition between multiple representations should be in the theoretical and practical courses given in teacher education programs.

Key words: physics; transitions in representations; verbal, graphical, table and physical representations

1. INTRODUCTION

The acquisition and use of information is increasingly complicated in the developing world, which rapidly changes. The acquisition and use of information facilitates the representation/presentation of information in social life. Nowadays, the presence of engagements which facilitates representation of information in all areas from popular sources like TV and internet to mainly scientific sources like schools and universities are noted in this sense. We can say that one of the applications which is conducted in this sense is the multiple representations of information.

When it is considered that there is need of external supporting in acquisition of information of individuals (Lappi, 2007), it can be said that the external supporting having increased diversity gives more effective results. In this context, it is stood out that multiple representations have positive/permanent effects on the concept learning in the studies which was conducted in the field of science education (Ainsworth, 2006; White, 1993; Zou, 2000; Huevelen & Zou 2001). In this sense, the graphics, tables, images, shapes, verbal, and so on representations are used in conjunction with the support of technology for the concept education in learning environments that are configured in recent years. It is clear that the teaching of concepts with multiple representations has important contributions.

The teaching activities which are carried out with multiple representations are helpful in constructing the students' cognitive structures like a map (Schontz, 2002; Schnotz & Bannert, 2003). In this process, the role of each representation completes mental structure or reflects the mental structure. In this sense, the multiple representations are effective to gain knowledge of transition skills between different types of representation (Huevelen & Zou 2001; Sağlam Arslan & Kurnaz, 2011; Zou, 2000). Another positive contribution to use multiple representations in the process of teaching is that this increases student performance (Scaife & Rogers, 1996; Goldman, 2003; Ainsworth, 2006). In addition, it can be expressed that multiple representations will facilitate communication between individuals in the learning environment.

It is clear that there must be effective communication between teacher and students for effective learning/teaching process at the classroom. For this reason, teachers must know communication factors well and must use well. One of the skills of which teachers must have recently, the communication closely relates to establishment of relations between pictorial, graphical, verbal, symbolic etc. representations of concepts at science lessons. In other words, one of the most important skills of teachers is to offer information with multiple representations (Hitt, 1998). For example, the topics and problems are mainly provided with texts at many textbooks. What is expected from teachers is to give picture, table, graph, mathematical equality etc. which refers these texts when necessary. In a clear understanding, it is to make transitions between representation types for example from text to others. In fact, it relates to internalize different representations of information as well. According to some researchers (Duval, 1995; Even, 1998; Hiebert & Carpenter, 1992; Piez & Voxman, 1997) the right use of representation types regarding any information and making transition between them are the indicator of learning information. Therefore, what is expected from teachers and also students is to make transitions between different representation types of information as an indicator of learning.

We can look from different perspective about skills of teachers to create/ use and make transition between multiple representations. In some studies (e.g. Cin, 2009; DeBerg, 2008; Leite, 1999; Sözbilir, 2003), it appears that one of the underlying reasons for the students' misconceptions is inadequate teaching materials. In other words, the presentation of information in teaching materials is incomplete or incorrect. It is considered that teachers having inadequate teaching materials might prevent misconceptions by creating/using multiple representations. Because the presentation of multiple representations of information will give students an opportunity to compare different types of presentation, and will help to structure the information in a controlled manner.

When considering the matters associated with advantages of the use of multiple representations above, the qualifications of teachers and student teachers are gained importance. This study aims at investigation of transition between multiple representations of student teachers. The research questions are as follows.

1. Do the student teachers make transition from verbal representations to graphic, table and pictorial representations which are mostly used in lessons?
2. In which representation types the student teachers are seen themselves as successful? Are their self-assessment consistent with their success?

2. METHODOLOGY

Since case study method allows a researcher to investigate a phenomenon within its real context and to collect detailed information in a sustained period of time (Yin, 2003; Merriam, 1998), the study was conducted as a case study. The case that was examined within the scope of the study involves the skills translating verbal representation to graphical, table and physical representations.

2.1. Study Group

The study group was consisted of a total of 45 student teachers. In forming process of the study group, a criterion-based purposive sampling strategy was applied. The criteria for selection were for all student teachers to be in their final year and to have whole theoretical and practical courses related with the content knowledge and pedagogical knowledge.

2.2. Instrument

This study utilized an achievement test which consists of two sections. The first section included three open-ended conceptual questions on pressure subject and the second section had one question on the same subject, requiring changes of verbal representations to graphical, table and physical representations. In fact, the first section was prepared to give clues about students' adequacy to answer second section. Conceptual questions asked in the first phase as follows:

1. What is Pressure? Explain.
2. Describe the relationship between pressure and surface area.
3. Please write factors that affect the liquid pressure.

Question that requires passing from verbal representation to the others is below:

4. Elif is planning to make experiment with two containers in different size. She is filling water in equal amount inside these big and small containers, and is observing water heights in these containers. She sees that water level at the big container present a steady increases (with a constant rate) and water level at the small container also present an increase by time but with an increasing rate.
   a. According to the text, draw shapes of big and small containers.
   b. According to the text, draw the graphics showing change of pressure by time, which is applied during filling of containers.
   c. According to the text, tabulate fluid pressures and pressures affecting bottom of containers after containers are filling in water by using big, small or equal expressions.

In the achievement test, student teachers were also asked about what kind of representation type they preferred (at what kind of representation types they felt more successful), and they were also required to score (easy, normal and hard) difficulty level of the questions. A pilot application of the achievement test was conducted with 15 student teachers, and it was found sufficient in terms of readability and understandability.

2.3. Data Analysis

The data was analyzed using descriptive methods. The analysis initially focused on the distribution of preferred representation types. Then, all of the responses provided were examined in terms of the success (correct answers) and failure (wrong and no answers) states of student teachers. This analysis approach is frequently used in studies (e.g. Hitt, 1998; Çelik & Sağlam Arslan, 2012) that investigate participants' translating skills in multiple representations. Moreover, an external expert, who holds a doctoral degree in the field of physics, was contributed to the whole analysis. By working independently, the expert and researcher categorized responses. Agreement rate between the coders was calculated as 95 % according to Miles and Huberman's (1994) formula. In sum, the frequencies of the findings were provided, and the most frequent errors were also illustrated in the analysis.

3. RESULTS

Results were presented under four main headings: "*Self-assessments of Participants*, *Results Obtained From Answers Given To the Conceptual Questions Regarding This Topic*, *Success distributions in representation changes*, and *Comparison of Success for Transition between Representations with Self-Assessment".*

3.1. Self-assessments of Participants

The representation type which is qualified by student teachers as most successful in drawing/writing and commenting is given in Table 1 in as comparative manner.

Table 1. Distribution of representation type that student teachers see themselves as most successful/preferred

			Interpreting the representation					
Writing or drawing the representation	Preferred		Verbal	Graphical	Table	Physical	Total	
							f	%
	Verbal		7	2	2	1	12	26,7
	Graphical		1	4	3	1	9	20,0
	Table		1	5	9	2	17	37,8
	Physical		3	2	-	2	7	15,5
	Total	f	12	13	14	6	45	100
		%	26,7	28,9	31,1	13,3		

It appears in Table 1 as most striking result that the student teachers in the study mostly express themselves as successful in creation of table about drawing/writing representation types. It is noted that they feel themselves as less successful at pictorial representations about commenting representation types. When we comparatively investigate the status of drawing/writing and commenting, the number of student teachers are very less, who make coding at the same time for both in any type of representation. According to this, only 9 student teachers see themselves as successful in tables, 7 student teachers in verbal, 4 student teachers in graphics and 2 student teachers in figure representation.

3.2. Results Obtained From Answers Given To the Conceptual Questions Regarding This Topic

The success distributions in questions which require verbal answering and take part in scope of first section of data collecting tool of student teachers, and their self-assessment regarding questions are given in Table 2.

Table 2. The success distributions of student teachers in conceptual questions

Question	ASTQ	**Correct**		**Incorrect**		**Abstention**		**Most frequent error**	
								Sample quotation	**f**
1	Easy	39	39	4	5	-	1	Pressure is the force acting perpendicular to the surface.	4
	Normal	-		1		-			
	Hard	-		-		1			
2	Easy	38	44	1	1	-	-	Pressure is the force applied to the surface area.	1
	Normal	6		-		-			
	Hard	-		-		-			

ASTQ: Assessment of Student Teachers about Question

As seen in Table 2, when we investigate answers related to correlation between pressure and pressure and surface area, it was found out that almost all participants give right answers. Moreover, almost all participants reflect their self-confidence regarding this topic, and say that questions are easy. Likewise, those who gave incorrect answer also said that questions are easy.

The distribution of answers regarding factors that affect pressure of still waters and their self-assessment regarding this question was given in Table 3.

Table 3. The factors affecting pressure of still water according to the student teachers

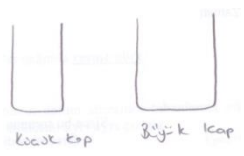
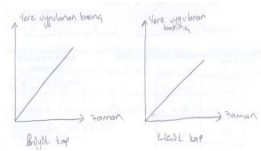
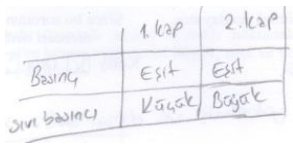
Question	ASTQ	Factor						
		Altitude	Density	Acceleration of gravity	Shape of container	Volume	Heat	Quantity of liquid
3	Easy	32	31	13	2	-	-	-
	Normal	7	5	3	4	2	1	1
	Hard	-	-	-	-	1	-	-
	Total	39	36	16	6	3	1	1

As seen in Table 3, majority of the participants said that the height and density affects pressure of still water and approximately one third of them say that acceleration of gravity affects. A small number of participants said that shape, volume, temperature and liquid amount of the container are other factors affecting pressure of still water. In fact, these participants are those classified in incorrect or unanswered category in Table 2.

3.3. Success distributions in representation changes

The success distributions of student teachers in transition from verbal to other representation types, and their qualifications for the questions are given in Table 4.

Table 4. The success distributions of student teachers from verbal to other representation types

Question	Expected representation	ASD	Correct		Incorrect		Abstention		Most frequent error	
									Sample quotation	f
a	Physical	Easy	7	12	19	30	-	3		26
		Normal	4		7		-			
		Hard	1		4		3			
b	Graphic	Easy	3	10	17	30	-	5		24
		Normal	6		7		-			
		Hard	1		6		5			
c	Table	Easy	2	7	5	23	-	14		9
		Normal	4		9		-			
		Hard	1		9		14			

When Table 4 is examined, the student teachers who reveal correct transitions were mostly successful in transition from verbal to shape. However, it is noted that there is no appear successful difference between transition from verbal to graphics and verbal to table representation types. The student teachers mostly had difficulties in transition from verbal to table representation types. Only 1 student teacher is successful in all transition types.

When mostly repeated faults are examined in Table 4, it is possible to mentioned common faults for each transition from verbal to shape, verbal to graphics, and verbal to table. The student teachers did not draw the pictorial of small container during transition from verbal to shape. Mostly repeated fault is that they didn't correctly comment the height of water in small container gradually increases. The student teachers thought that the height of water increased in fixed speed, and they draw container which was perpendicular to the floor and was narrower than big container. Likewise, they cannot draw the graphic showing the change of pressure at small container at transition of verbal to graphic. In fact, what is expected from student teachers is that they must parabolically show the increase in the graphic due to narrowing and must draw a shape of container narrowing upwards. Here, the fault is that student teachers ignore the feature of the increase in water level. Only one student teacher focused on increase, and drawn linear figure and/or graphic. This result complies with the results from previous studies

(Hadjidemetriou & Williams, 2002; Leinhardt et al., 1990; Padilla & et al., 1986). When mostly repeated fault was examined in transition from verbal to the table, it was found that the student teachers wrongly showed the pressure of big and small container on table. The mostly made mistake at transition from verbal to table is that it complies with graphics the student teachers drawn, it doesn't comply with pictorial.

In Table 4, when self-assessment of student teachers for transitions between representation types, it was found that almost half of them made easily definition for transition from verbal to graphic and shape. It was found that less number of student teacher said that it is easy for transition from verbal to table. Here, it is obvious that the student teachers had difficulties in transition from verbal to table, and they are confident in shape and graphic representation types (especially those made wrong transition).

3.4. Comparison of Success for Transition between Representations with Self-Assessment

The comparison of success distributions for transitions provided for Table 4 with certain preferences for representation types at the Table 1 under this topic was performed. This comparison was given in Table 5. In the comparison, only students who gave correct answer – made right transitions – were considered.

Table 5. Comparison of Successes for Transition between Representations with Self-Assessment

	Verbal		Graphic		Table		Physical	
Transition	**Writing**	**Explain**	**Draw**	**Explain**	**Draw**	**Explain**	**Draw**	**Explain**
From verbal to physical	4	1	2	6	3	4	1	1
From verbal to graphic	3	-	-	5	4	3	2	2
From verbal to table	2	2	3	2	3	3	-	-

In Table 5, it appears that none of student teachers who define themselves as successful in drawing graphics, only three of student teachers who define themselves as successful in drawing table, and only one who define himself/herself as successful in drawing pictorial are successful.

4. DISCUSSION AND CONCLUSION

In this study, the responses of student teachers including passing from verbal representation to graphical, table and physical representations were used in order to determine their skills of using/switching multiple representations. First of all, the results were indicated that student teachers had generally provided an acceptable level on understanding the pressure subject. However, almost all of them have found insufficient in switching between representations. Thus, it is thought that this study sets forth implications for educators to elicit barriers in the research subject.

When the representation types which preferred by the student teachers were examined, the most striking case was that most of them generally considered themselves as successful in only constructing or interpreting on their own preference. When the findings of conceptual questions were examined, it could be highlighted that almost all of the participants could provide scientific definition of pressure. Based on this case, it was hoped from participants to represent pressure concept with various representations. However most of them did not performed the transitions given in the second section. Since transitions between representations is directly related with the learning (Duval, 1995), the process of presenting a subject in various representations and ability of students to use these representations are very important in science education (Even, 1998; Hiebert & Carpenter, 1992; Piez & Voxman, 1997). Moreover, it can be highlighted that the student teachers were also unsuccessful in their preference that they deem themselves successful. In sum, although the student teachers were in sufficient in defining pressure by using verbal representation, they did not pass from verbal representation to the others, and their self-evaluation were not consistent with their success. May be the main reasons of this results were related to evaluation methods that direct students to solve problems without utilizing transitions between representations in courses or textbooks.

Teachers generally use well-known techniques by themselves to facilitate learning process. Baked by the results, it can be claimed that the student teachers may teach pressure concept by utilizing verbal representation. However, since a representation just highlights limited characteristics of a concept, researchers recommend using various representations for meaningful learning (Cuoco, 2001; De Jong et al., 1998; Kaput, 1992). Since the student teachers did not success the transitions in this study, it can be claimed that they may not construct excellent learning environments regarding with multiple representations in the future. However, one of the initial responsibilities of a teacher should facilitate learning process. To this end, multiple representations provide effective opportunities (Ainsworth, 2006; Goldman, 2003; Huevelen & Zou 2001; Scaife & Rogers, 1996; Schontz, 2002; Schnotz & Bannert, 2003; Zou, 2000), and teachers have to know and use transition skills between representations.

Many researches that investigated transition skills of teachers or student teachers (e.g. Billings & Klanderman, 2000; Çelik & Sağlam Arslan, 2012; Hitt, 1998; İpek & Okumuş, 2012) were claimed as a common result that teachers had lack of skills on transition between representations. In this study, the student teachers were not put forth an expected performance once more. It is thought that there is a dilemma in educating student teachers. As a remedy, theoretical and practical courses given in teacher education programs should include the applications to improve teacher candidates' skills of transition between multiple representations. To reinforce the

results of the current study, there is need for new researches that investigates not only skills of student teachers, but also instruction process in theoretical and practical courses in university.

This study was carried out restricted participants, including 45 student teachers. The results may not accept in a wide meaning. Requiring only transition from one representation to the others could also be considered as another limitation of the study. Therefore, more studies investigating transition skills in multiple representations will also be beneficiary in contributing to the results of this study.

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